Subjective Sleep Characteristics of 1,485 Males and Females Aged 50–93: Effects of Sex and Age, and Factors Related to Self-Evaluated Quality of Sleep

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Background. This epidemiologic study cross-sectionally examined the effects of sex and age on subjective characteristics of sleep and the factors related to self-evaluated sleep quality in a Dutch noninstitutionalized elderly population.

Methods. 1,692 sleep questionnaires were mailed to all attenders of the general practice serving Krimpen aan de Lek, The Netherlands, aged 50 or over. Both target population and responders (1,485 subjects) were virtually representative of the Dutch population regarding sex and age (50 +) characteristics.

Results. Overall, females reported significantly poorer quality of sleep, longer sleep latencies, more nighttime awakenings, less frequent napping, and more frequent use of sedative-hypnotic drugs when compared to males. Additionally, there was a female predominance in the prevalence of disturbed sleep onset and sleep maintenance, whereas a male predominance was observed in the prevalence of excessive daytime sleepiness. Across subjects, a significant age-related increment was found for sleep latency time and time spent in bed. The number of nighttime awakenings increased significantly with age only in males. No significant correlations were found between health status and sex, age, or subjective sleep quality. The most frequently reported causes of disturbed sleep onset and sleep maintenance were worries and nocturia, respectively. Subjective quality of sleep was mostly associated with self-estimated sleep latency.

Conclusions. Our findings extend those of previous epidemiologic studies reporting that sleep disorders are common in the general elderly population. Future studies should further elucidate the nature and extent of geriatric sleep disorders to satisfy the increasing need for its accurate diagnosis and treatment.

S EVERAL population-based surveys have shown that the prevalence of self-reported poor sleep increases with age up to 40% after the age of 60 (1–13). Poor sleepers subjectively experience longer sleep latencies, frequent nocturnal awakenings, less total sleep time, more difficulty initiating and maintaining sleep, and excessive daytime sleepiness (EDS; 4,14–16). Many investigators report a female predominance in poor sleep, especially after 45 years of age (1,3–6,8–11,13,17–22). Concomitantly with these reports, females are more frequently users of sedative-hypnotic medication.

Most population-based studies on subjective sleep characteristics lack detail concerning the elderly population, as these studies are based on random population samples and do not assess poor sleep by subject's own evaluation of sleep quality (1,3–6,8–11,13). Given the rapid increase in the elderly population and the fact that elderly people have more sleep complaints and use more hypnotic drugs, it therefore is of great importance to characterize the prevalence of sleep disorders and understand its relation to subjective quality of sleep to optimize the diagnosis and treatment of these disorders. Moreover, surveys of sleep and sleep complaints have been carried out in different cultures and communities (1,3–5,7,8,10,13,18,20–23), but only limited Dutch data on this important aspect of aging have been reported.

In the present study we first examined the role of sex and age on sleep habits and the prevalence of sleep disturbances and their possible causes. Secondly, we identified the nocturnal and post-sleep experiences that are most strongly associated with self-evaluated quality of sleep in a large, geographically defined, noninstitutionalized elderly population.

METHODS

Study population. — The survey was conducted in the small suburban village of Krimpen aan de Lek, The Netherlands, at the end of 1992. Krimpen aan de Lek is located 10 miles east of Rotterdam and had a total population of 6,747 inhabitants (3,399 males and 3,348 females) as of January 1, 1993. At the time of the survey, 93% of all inhabitants were registered at the local general practice center. Chi-square (χ^2) analyses revealed that the distribution of male and female inhabitants across age groups (decades) differed significantly ($p < .01$) from that in the general Dutch population; the latter comprises relatively fewer females aged 50–59 and more elderly subjects older than 80 years (Table 1). This is most likely explained by the fact that the community lacks any long-term health care facilities, such as hospitals and nursing homes. The target population consisted of all 1,692 inhabitants aged 50 years or older who were registered

Table 1. Population Characteristics (sampled January 1, 1993) of The Netherlands, the Village of Krimpen aan de Lek, the General Practice of the Village of Krimpen aan de Lek (sample), and the Respondents

Age	The Netherlands				Krimpen aan de Lek				General Practice				Respondents			
	Males		Females		Males		Females		Males		Females		Males		Females	
50–59	787349	(41%)	772076	(33%)*	385	(44%)	395	(42%)	348	(44%)	355	(40%)	300	(43%)	307	(39%)
60–69	617005	(32%)	695765	(30%)	293	(33%)	286	(30%)	271	(34%)	281	(31%)	231	(33%)	249	(32%)
70–79	371046	(20%)	537097	(23%)	165	(19%)	193	(20%)	148	(18%)	190	(21%)	144	(20%)	165	(21%)
80+	138367	(7%)*	318024	(14%)*	35	(4%)	71	(8%)	31	(4%)	68	(8%)	30	(4%)	59	(8%)
Total	1913767	(100%)	2322962	(100%)	878	(100%)	945	(100%)	798	(100%)	894	(100%)	705	(100%)	780	(100%)

Notes: Pairwise comparisons (χ^2-analyses) of populations revealed no significant differences regarding the distribution of subjects across age and sex groups between the village of Krimpen aan de Lek, the general practice of the village of Krimpen aan de Lek (sample), and the respondents. The population of The Netherlands differed significantly (*$p < .05$) from the other populations and comprises significantly more elderly aged 80+ and significantly fewer women aged 50–59 years as revealed by post hoc comparisons of decades.

at the general practice center at the time of the survey. The study was approved by the Leiden University Hospital Ethics Committee for Medical Research.

Sleep questionnaire. — The sleep questionnaire consisted of 26 questions concerning sex, age, health status, substance use (alcoholic beverages, tobacco, and sedative-hypnotic drugs) and sleep habits including timing and amount of diurnal and nocturnal sleep and habitual quality of subjective sleep (5-point scale: 1 = excellent sleep to 5 = very poor sleep). In addition, we also asked for the presence of a current problem with any of the main categories of sleep/wake disturbances:

(a) Disturbed sleep onset (self-estimated sleep latency time >30 minutes).
(b) Disturbed sleep maintenance (three or more nocturnal awakenings).
(c) EDS, defined as a daily presence of inappropriate and irresistible sleep during daytime.

Sleep apnea syndrome (SAS) and periodic limb movement disorder (PLMD) have been reported to be associated with increasing age and sleep complaints (24–26). Therefore, we included specific questions about the prevalence of associated features of these syndromes, namely, the presence of habitual snoring and restless legs just prior to sleep onset and/or nocturnal involuntary leg movements, respectively (26). To increase the reliability of replies to these items, subjects were instructed to have their responses verified by their bedpartner, if present.

Decreasing physical and mental health associated with detrimental effects on sleep/wake is a well-known phenomenon of aging. For this purpose, we evaluated if the subjects experienced any physical health problem(s). Only the first three complaints were considered in case multiple physical health problems were indicated. They were classified among the following major categories of disease: (a) circulatory, (b) respiratory, (c) urogenital, (d) neurological, (e) dermatological, (f) musculoskeletal, (g) gastrointestinal, (h) endocrinal, and (i) others. With respect to their self-perceived mental health, subjects were asked if they felt depressed. Depression is probably the most common mental illness affecting the elderly and often leads to disturbed sleep/wake patterns (11,26).

The time frame used on the questionnaire was the last 3 months, unless stated otherwise. Sleep habits and physical health status were asked in open-ended format. Substance use on a regular basis and frequency of napping were assessed by 2-point (0 = no, 1 = yes) and 4-point rating scales (1 = never, 2 = sometimes, 3 = often, and 4 = always), respectively. EDS, PLMD, and depression were assessed with similar 4-point rating scales. For reasons of comparability with previous sleep studies of our group, frequency of snoring was assessed by a 5-point scale (1 = never, 2 = less than once a week, 3 = 1–2 nights a week, 4 = 3–5 nights a week, and 5 = almost nightly/daily). Items were considered clinically relevant (substance use and napping) or "disturbed" if a score was ≥3, except for the frequency of snoring, which was regarded as clinically relevant (habitual) when a score was ≥4. Possible causes of disturbed sleep onset and/or sleep maintenance were also evaluated and were addressed in an open-ended question format.

Procedure. — The sleep questionnaires accompanied by an introductory letter from the local general practitioner (AKN) were mailed at the beginning of October 1992. They were followed by two reminders within a period of two months. Each returned questionnaire was entered into two separate data bases. After entry of all questionnaires, the two data bases were compared one-to-one and any discrepancy (type-errors and/or classification errors) was discussed and subsequently corrected.

Statistical analysis. — Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS/PC+; 27). Logistic regression analysis (categorical variables) and two-way analysis of variance (ANOVA) (continuous variables) were carried out to test differences between groups (sex and decade) as well as their interactions. If the χ^2, logistic regression, or ANOVA statistics had a significant *p*-value, it was followed by a test for presence of a linear trend in the means as function of age (decade) and post-hoc multiple comparisons of groups.

Multiple linear regression analysis was used to identify the measures which were most strongly associated with self-assessed quality of sleep. The forward method of entering the independent variables ($p_{out} = .01$) was used. Because of

multiple testing, the nominal level of statistical significance was adjusted from $p < .05$ to $p < .01$.

RESULTS

Response Rate

After two reminders, a response rate of 87.8% (1485/1692 subjects) was eventually obtained. Chi-square analyses revealed that the distribution of the respondents across decades was similar to that of the original sample as well as to that of the 50+ population of the village of Krimpen aan de Lek. The distribution of the respondents across the four decades differed slightly from that of the general population of The Netherlands and comprised significantly more females in the 50–59 age group and significantly fewer elderly in the 80+ group (Table 1).

Sex, Age (Decade), and Sex × Decade Effects

General characteristics of the subjects. — Table 2 shows the general characteristics of the respondents, viz. age, body mass index (BMI), health status, and substance use by sex and by decade. Within decades, age did not differ significantly between sex groups. With respect to the health status of the respondents at the time of the survey, 722 (48.6%), 205 (13.8%), and 40 (2.7%) subjects reported to suffer concomitantly from one, two, or three somatic diseases, respectively, whereas 91 (6.1%) subjects reported feeling depressed. The total of 967 reported somatic complaints were distributed along the following main categories of diseases: musculoskeletal: 308 (31.9%); neurological: 80 (8.2%); respiratory: 78 (8.0%); endocrinal: 75 (7.7%); gastrointestinal: 72 (7.4%); circulatory: 72 (7.4%); urogenital: 31 (3.2%); dermatological: 24 (2.5%); and others: 227 (23.7%). BMI and health status as defined as the prevalence of one, two, or three somatic complaints and the prevalence of self-reported depression did not vary significantly across sex or age groups.

Significantly more males smoked and used alcoholic beverages than females, whereas females significantly more often used sedative-hypnotic drugs on a regular basis. Sedative-hypnotic drugs were used by 245 (16.5%) subjects. Moreover, for all these substances a significant decade effect was found; across subjects, smoking and the use of alcoholic beverages showed a significant linear decrease with increasing age, whereas the use of hypnotic-sedative drugs showed a significant linear increase over the subsequent decades. For all general characteristics, no significant Sex × Decade interactions were found (Table 2).

Sleep habits. — Overall, females reported significantly longer sleep latencies and significantly more awakenings after sleep onset (Table 2). Although the absolute differences were quite small, females also got up later and spent more time in bed during the nocturnal period. No significant differences between males and females were found for "lights out" time, time of definitive awakening and, consequently, total sleep time. Regarding daytime sleep, males significantly more often reported napping than females.

For almost all nocturnal and diurnal sleep measures a sig-

nificant effect for age was found. Post-hoc comparisons revealed that subjects in the age group 80+ went to bed and turned off the lights significantly earlier. Sleep latency showed a significantly positive linear relation with age, although no significant difference was found between the age groups 60–69 and 70–79. A significant Sex × Decade interaction was found for the number of nighttime awakenings after sleep onset; across decades the number of nocturnal awakenings increased significantly in males, whereas in females the number of awakenings remained similar across decades. No significant decade effect or Sex × Decade effect was found for the time of definitive awakening. Rise time, however, showed a significant age as well as a significant Sex × Age effect. Post-hoc analyses revealed that wake-up time was significantly earlier among subjects aged 50–59 years than in other age groups. Time spent in bed showed a significant linear increase along the successive decades and was significantly at highest level in the 80+ group. A similar trend was observed for total sleep time, though the difference between the 6th and 7th decade failed to reach the level of statistical significance.

Regarding subjective sleep quality, only a significant main effect for sex was found, i.e., across decades females reported experiencing significantly poorer sleep than males.

Sleep disturbances. — Overall, disturbed sleep onset, disturbed sleep maintenance, and EDS were reported by 190 (12.8%), 375 (25.3%), and 209 (14.1%) respondents, respectively. Moreover, habitual snoring, habitual snoring combined with EDS, PLMD, and PLMD combined with EDS were reported by 434 (29.2%), 87 (5.9%), 102 (6.9%), and 27 (1.8%) respondents, respectively. Across decades, a significant female predominance was found in the prevalence of disturbed sleep onset and disturbed sleep maintenance, whereas a significant male predominance was observed for EDS, habitual snoring, and habitual snoring combined with EDS (Table 2).

Across sex groups, the prevalence of disturbed sleep onset showed a linear increase across decades with significantly highest prevalence in the 80+ group. Compared with disturbed sleep onset, the prevalence of habitual snoring combined with EDS showed a significantly inversed age relation, although post-hoc comparisons revealed no significant differences between decades for this measure. A significant Sex × Decade effect emerged only for disturbed sleep maintenance, i.e., across the decades the prevalence of this sleep disturbance significantly increased in males, whereas no significant age-related changes occurred in the females. Regarding the reports on the presence of PLMD and PLMD combined with EDS, no significant sex, decade, or Sex × Decade effects were observed.

Causes of disturbed sleep onset and sleep maintenance. — Causes for disturbed sleep onset and maintenance were reported by 470 (31.6%) and 1,117 (75.2%) subjects, respectively. For those subjects, for each category only the four major complaints were considered (Table 3). The most frequently reported cause for disturbed sleep onset was worries, followed by an unknown cause, anxiety, and sleeplessness. Significant decade effects were found for worries

Table 2. General Characteristics, Characteristics of Nocturnal and Diurnal Sleep, Subjective Sleep Quality, and the Prevalence of Sleep-Wake Disturbances†

	50–59		60–69		70–79		80+		ANOVA/Logistic Regression		
	Males	Females	Males	Females	Males	Females	Males	Females	Sex	Age	Sex × Age
General characteristics											
N	300	307	231	249	144	165	30	59			
Age	54.3 ± 2.8	54.2 ± 2.9	63.9 ± 2.8	64.3 ± 3.0	74.1 ± 2.9	74.1 ± 2.9	83.1 ± 3.2	83.5 ± 2.5			
Body mass index (kg*m⁻²)	24.9 ± 4.6	25.2 ± 4.2	25.5 ± 4.1	25.4 ± 5.3	24.2 ± 5.5	24.5 ± 7.3	24.0 ± 5.4	24.1 ± 6.7			
Physical complaint (%)	42.7	48.5	47.2	52.6	48.6	50.3	56.7	59.3			
Feeling depressed (%)	6.0	7.2	8.7	6.0	1.4	4.2	13.3	5.1			
Smoking (%)	37.1	23.5	34.2	15.4	31.9	3.2	23.3	3.4	#**	#**	
Use of alcohol (%)	79.3	52.3	77.0	34.6	59.0	25.9	53.3	24.1	#**	#**	
Use of hypnotic-sedatives (%)	4.3	15.0	11.5	21.3	16.9	36.8	26.7	28.6	#**	#**	
Nocturnal and diurnal sleep											
Time to bed (hr)	23:04 ± 0.41	23:02 ± 0.37	23:08 ± 0.43	23:02 ± 0.38	23:02 ± 0.43	22:49 ± 0.39	22:29 ± 0.49	22:29 ± 0.43		**	
Lights out (hr)	23:13 ± 0.43	23:16 ± 0.38	23:16 ± 0.43	23:17 ± 0.44	23:11 ± 0.42	23:02 ± 0.50	22:32 ± 0.52	22:37 ± 0.49		**	
Sleep latency (min)	12 ± 20	22 ± 28	13 ± 16	29 ± 32	18 ± 20	33 ± 33	16 ± 19	47 ± 44	**	**	
Number of nighttime awakenings	1.4 ± 1.4	2.1 ± 1.7	1.7 ± 1.1	2.2 ± 1.5	2.1 ± 1.4	2.1 ± 1.1	2.3 ± 1.3	2.1 ± 1.6	**		*
Time of definitive awakening (hr)	6:25 ± 0.54	6:44 ± 0.54	7:00 ± 1:00	7:01 ± 0.54	6:50 ± 1:00	6:32 ± 1:12	6:59 ± 0.42	6:31 ± 1:12			
Rise time (hr)	6:50 ± 0.53	7:18 ± 0.49	7:37 ± 0.54	7:43 ± 0.41	7:43 ± 0.50	7:45 ± 0.41	7:38 ± 0.46	7:44 ± 0.37	**	**	**
Time in bed (hrs)	7.8 ± 0.9	8.3 ± 0.9	8.5 ± 0.9	8.7 ± 0.8	8.7 ± 1.0	8.9 ± 0.8	9.1 ± 1.0	9.3 ± 0.8	**	**	
Total sleep time (hrs)	7.2 ± 0.9	7.5 ± 1.1	7.7 ± 1.1	7.8 ± 1.0	7.7 ± 1.1	7.5 ± 1.0	8.5 ± 0.8	8.0 ± 1.4		**	
Regular nap (%)	14.7	5.2	23.4	12.0	34.0	20.6	53.3	42.4	#**	#**	
Subjective sleep quality (1–5)	2.1 ± 0.8	2.6 ± 0.9	2.2 ± 0.8	2.7 ± 0.9	2.4 ± 0.9	2.9 ± 1.0	2.2 ± 0.8	2.9 ± 1.0	**		
Sleep/wake disturbances											
Disturbed sleep onset (%)	5.3	14.0	4.8	19.3	9.7	22.4	13.3	28.8	#**	#*	
Disturbed sleep maintenance (%)	14.7	29.3	19.0	30.1	31.3	29.7	36.7	28.8	#**		#*
Excessive daytime sleepiness (EDS) (%)	19.3	10.7	15.2	10.0	15.3	10.3	23.3	20.3	#**		
Habitual snoring (%)	44.0	21.5	39.0	22.1	36.1	15.2	10.0	18.6	#**	**	
Habitual snoring + EDS (%)	12.0	2.6	8.7	2.4	6.3	2.4	0	6.8	#**	#*	
Periodic limb movement disorder (PLMD) (%)	5.3	5.2	6.9	8.0	7.6	7.9	3.3	15.3			
PLMD + EDS (%)	1.7	1.0	2.6	2.4	2.8	0	0	5.1			

†Expressed as means ± SD by sex and by age group (decade) and the results of the ANOVA or logistic regression analyses.

*p < .01; **p < .001.

Logistic regression analysis.

Table 3. Prevalence (% of total) of the Main Causes of Disturbed Sleep Onset and Disturbed Sleep Maintenance†

	Totals			50–59		60–69		70–79		80+		Logistic Regression		
	50–93 All	50–93 Males	50–89 Females	Males	Females	Males	Females	Males	Females	Males	Females	Sex	Age	Sex × Age
Causes of disturbed sleep onset (%):	N = 470													
Worries	54.0	53.0	54.4	63.0	64.5	54.5	51.3	41.2	43.3	25.0	46.7		**	
Unknown	25.7	27.2	25.1	24.1	13.7	18.2	30.1	44.1	35.8	37.5	33.3		**	
Anxiety	5.5	2.6	6.9	0	5.6	5.5	4.4	0	10.4	12.5	20.0			
Sleeplessness	3.4	5.3	2.5	3.7	2.4	9.1	2.7	2.9	3.0	0	0			
Other	11.3	11.9	11.0	9.3	13.7	12.7	11.5	11.8	7.5	25.0	0			
Causes of disturbed sleep maintenance (%):	N = 1117													
Nocturia	67.5	72.1	63.5	66.8	58.6	73.9	60.7	74.4	72.8	91.3	72.1	**	**	
Unknown	15.5	15.2	15.7	16.3	15.8	14.1	16.3	17.1	15.4	4.3	14.0			
Anxiety	3.0	1.3	4.4	1.0	4.1	1.6	5.6	1.7	2.9	0	4.7	**		
Worries	2.2	1.2	3.2	1.5	3.6	1.6	4.6	0	1.5	0	0			
Other	11.8	10.2	13.2	14.3	18.0	8.7	12.8	6.8	7.4	4.3	9.3		**	

†By sex and by age group (decade) and the results of the logistic regression analyses.
**$p < .001$.

and unknown as causes for disturbed sleep onset, which showed a significant linear decrease and increase across decades, respectively. No significant differences between males and females emerged with regard to the causes for disturbed sleep onset.

Nocturia was the most frequently reported cause for disturbed sleep maintenance. The second, third, and fourth most frequently reported cause was unknown, anxiety, and worries, respectively. Across decades, significantly more males reported nocturia as cause for disrupted nighttime sleep. Moreover, for all subjects the prevalence of nocturia showed a significant linear increase across the successive decades. Anxiety as cause of disturbed sleep maintenance was significantly more often reported by women than by men, whereas with increasing age significantly fewer subjects were ignorant of the cause for nighttime sleep disruption. No significant Sex × Decade interaction was found for any of the aforementioned causes of disturbed sleep onset and maintenance.

Subjective Indicators of Self-evaluated Quality of Sleep

To identify the measures that are related to subjective quality of sleep, all sleep questionnaire measures as listed in Table 1 (except for disturbed sleep onset and sleep maintenance) and Table 2 (only the first four causes of disturbed sleep onset and sleep maintenance) including sex and age were entered as independent variables into a multiple regression analysis with sleep quality (1 = excellent to 5 = very poor) as dependent variable. Only measures which contributed for at least 1% to the total squared canonical correlation were allowed to be selected into the model. It was found that subjectively poor sleep was significantly associated with longer sleep latency times ($r^2 = 32\%$), more nocturnal awakenings ($r^2 = 8\%$), shorter total sleep time ($r^2 = 3\%$), usage of hypnotic-sedative drugs ($r^2 = 2\%$) and a female dominance ($r^2 = 2\%$). Together these measures accounted for 47% of the variation in subjective sleep quality. Similar results were found when physical health status was entered

as a continuous "severity" scale (number of physical complaints (0, 1, 2, or 3) instead of the primarily entered dichotomous (0 = not present; 1 = present) measure.

DISCUSSION

This is the first epidemiological study in English literature describing subjective characteristics of sleep and the prevalence of sleep disturbances in a geographically defined Dutch, noninstitutionalized community-based sample consisting of 1,692 elderly aged 50–93 years, of whom 1,485 (88%) were ultimately studied. The sample was representative of the general Dutch population regarding age and sex characteristics, except for the 5th decade and 80+ group, which comprised relatively more females and relatively fewer subjects, respectively.

Overall, our results revealed conspicuous effects for sex and age for almost all measures. Across age groups, females reported significantly poorer quality of sleep, longer sleep latencies, more nighttime awakenings, less frequent napping, and more frequent use of sedative-hypnotic drugs when compared to males. Females also got up later and spent more time in bed during the nocturnal period, although the absolute sex differences for these measures were quite small. Additionally, there was a female predominance in the prevalence of disturbed sleep onset (self-estimated sleep latency time >30 minutes) and sleep maintenance (three or more nocturnal awakenings), whereas a male predominance was observed in the prevalence of EDS, habitual snoring, as well as their combined occurrence. Across subjects, sleep latency time and time spent in bed increased significantly with age. Interestingly, the number of nighttime awakenings and, by definition, the associated prevalence of disturbed sleep maintenance increased significantly with age only in males. Across subjects, the most frequently reported causes of disturbed sleep onset and sleep maintenance were worries and nocturia, respectively. Finally, we found that, in order of importance, sleep latency time, the number of nocturnal

awakenings, total sleep time, hypnotic-sedative drug usage, and a female predominance are significant indicators of self-reported sleep quality, accounting in total for 47% of the variability in sleep quality.

Our results are consistent with most previous studies reporting high prevalences of insomnia, EDS, and hypnotic-sedative drug use in the elderly, especially in females (1,3–6,8–11,13,17–22). Although comparability among studies is hampered to some extent by methodological differences, the absolute prevalences of insomnia [of which disturbance of sleep maintenance (25.3%) was more often reported than disturbed sleep onset (12.8%)], EDS (14.1%), and use of sedative-hypnotic drugs (16.5%) observed in our elderly population are slightly lower than in other studies (3,5,6,8,10,13,20–22). These relatively lower prevalences are conceivably associated with the relatively good general health condition of our population caused by the absence of any kind of local elderly health care facilities, that eventually force elderly who need long-term medical care to move out of town.

Although several sleep/wake disturbances predominate in this elderly population, self-estimated sleep latency time emerged to be the factor most strongly associated with self-reported sleep quality. It appears that most elderly people may be defining a sleep problem mainly on the criteria of sleep onset difficulty, rather than on other clinically important criteria, such as the frequency and cause of nocturnal awakenings and EDS. Overall, the outcome of the multiple regression analysis conforms to several other studies (14–16,18,19), although it must be noted that in our study the contribution of total sleep time, sedative-hypnotic drug usage, and sex to the variance of subjective sleep quality is relatively small.

Surprisingly, in our study age, physical and mental health status often reported to be related to poor quality of subjective sleep (1,9–12,16,18–21) did not emerge as significant determinants of perceived quality of sleep. Several possible explanations for this finding should be considered. Firstly, our population comprised noninstitutionalized subjects and therefore may be assumed to be more healthy than the general elderly population. This is well illustrated by the lack of any age-related changes in the prevalence of reported physical and mental health problems across the successive decades. Secondly, the observed lack of significant correlations between health status and age and subjective quality of sleep in our study may also be explained by the type of employed methodology (self-reports) and applied criteria, which may be inaccurate to provide reliable estimates of the presence and severity of possible pathology. This, however, is most unlikely, since invariably all other surveys on this subject used comparable methodologies. Thirdly, the lack of a significant influence of age upon subjective quality of sleep may be the result of a relatively small variability in the data because we considered only subjects aged 50–93 years. Finally, it may be assumed that the elderly accept the age-related changes in sleep/wakefulness as a normal part of aging. There is still some disagreement as to the extent to which age-related changes in sleep patterns represent normal as opposed to pathological changes (28). In this context, neither napping nor EDS were significantly associated with

subjective quality of sleep. This supports the above-mentioned thesis that some age-related changes become a part of the normal sleep/wake pattern of elderly people. Also, in other studies the prevalence of napping was found to be equivalent among poor and good sleepers (15,19).

Consistent with findings of Morgan et al. (18) and Habte-Gabr et al. (21), we found a significant age-related linear increase for self-estimated sleep latency time and time in bed. The marked earlier time of awakening and wake-up time of subjects 50–59 years of age compared with those aged 60–69 years is probably caused by the presence of subjects in the former age group who were still employed; in The Netherlands, retirement normally takes place between 60 and 65 years of age. Another interesting age-related finding was that the number of awakenings after sleep onset increased with age only in males, while it remained similar across decades for females. Menopause might account for such a remarkable difference between sexes (8,10,13). As a consequence, an increase in the amount of nighttime awakenings among females can be established in the years before the age of 50. Another possible explanation is provided by the age-related decrease in nocturnal antidiuretic hormone levels associated with increasing nocturia frequency, particularly in males (22). Interestingly, although nocturia was reported most frequently as cause for nocturnal awakenings, it was not associated with subjective quality of sleep.

Using open-ended questions, worries (54.0%) and unknown (25.7%) were most frequently listed as major factors involved with disturbed sleep onset. Similar results were reported by Lugaresi et al. (4) and Urponen et al. (29), although the latter found a female predominance for this factor. Another interesting finding in this study is that the factor "worries" significantly decreases with age, whereas an opposite relation was found for "unknown." Unfortunately, our questionnaire did not provide additional information to disentangle to what extent worries and anxiety were signs of possible underlying psychopathology, e.g., depression, generally known to have detrimental effects on sleep and to be common in the elderly population. On the other hand, other causes also often reported to be related to health status, such as pain (12,21), appeared relatively unimportant as subjective determinants for quality of sleep in this study. As stated earlier, nocturia was the most prominent cause for disturbed sleep maintenance (67.5%) and showed a significant linear increase across the successive decades and was significantly more prevalent among males. Surprisingly, only a few epidemiological studies reported nocturia as a major cause for nighttime awakenings in the elderly (20,30), which may be the result of differences in employed questionnaire formats (open-ended or check-list format) or characteristics of the studied populations.

In contrast with Gíslason et al. (22) but consistent with Hayter et al. (7) and Metz et al. (31), we found an increased frequency of napping with advancing age. Congruent with previous reports (7,22), male subjects napped significantly more than females. However, the prevalence of EDS did not increase with age. As suggested earlier (26), napping in the elderly may be incorporated in the normal sleep pattern, rather than that it compensates for daytime sleepiness or disturbed nighttime sleep. The clinical significance of EDS,

napping, and their relation to possible nocturnal sleep-related disorders in the elderly remains to be established.

Habitual snoring was reported by 29.2% of all subjects and was more common in males then in females, which corresponded with previous reports on this topic (32–35). However, contrary to two other studies (34,36), we found a slight but statistically nonsignificant decrement for this measure from the fifth to the ninth decade. This discrepancy is most likely due to differences between samples or as a result of underreporting, because many of the elderly could be unaware of their snoring habits. Moreover, the prevalence of snoring has been demonstrated to be lower among subjects without a cohabiting partner (33), particularly in the very elderly. Habitual snoring in combination with EDS is a clue to the presence of obstructive sleep apnea, and, as expected, the prevalence among males was higher than among females (26,37). We found an overall prevalence of habitual snoring in combination with EDS of 5.9%, which is slightly higher than was found earlier by Gíslason et al. (24). Another important sleep-related disorder addressed in this study was PLMD, which incidence appears to increase with age and has been reported to be related to metabolic and vascular as well as neurologic factors (25,26). Hitherto, exact figures about the prevalence of PLMD have not been known, but it has been reported to occur in up to 34% of patients over the age of 60 years (26). In our general population we found prevalences of 6.9% and 1.8% for PLMD and PLMD plus EDS, respectively. Moreover, we did not find any significant age-related change for these measures. Future epidemiological studies should reveal the incidence and prevalence of these disorders that presumably afflict a substantial number of elderly subjects (26).

In conclusion, our findings obtained in a Dutch elderly population extend those of previous studies reporting that sleep disorders are quite common in the general elderly population. In addition, sleep disturbances and sedative-hypnotic drug usage were more common among females, and tended to increase as a function of age. Because our population comprised relatively healthy subjects, the absolute prevalences of sleep disorders were somewhat lower as compared with other population-based studies. The most frequently reported causes associated with disturbed sleep onset and sleep maintenance were worries and nocturia, respectively. We also have demonstrated that self-estimated sleep latency time is the most important determinant of subjective quality of sleep. Future additional epidemiologic research using longitudinal designs may expand the present findings to further elucidate the nature and extent of geriatric sleep disorders to satisfy the increasing need for its accurate recognition, diagnosis, and treatment.

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